PATENT SPECIFICATION 922,007

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to Surgical Instruments.

I, THOMAS JOSEPH CONNELLEY, an Australian Citizen, of The Commercial Banking Company of Sydney Limited, West End Branch, 49/50 Berkeley Street, London, W.1, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to surgical instruments and has an important application in brain surgery, facilitating the positioning of an operating or other instrument at a precise location in the brain of the patient.

According to this invention an instrument for use in brain surgery comprises a hollow plug for assemblage in a hole formed in the skull of the patient which plug forms the sole support for the instrument on the patient's head, a guideway fixed to the plug and arranged to constrain a part of another guideway to swing about a first axis transverse to the axis of the hollow plug which other guideway constrains an instrument-holder to swing about an axis at right angles to and intersecting the first axis and axis of the hollow plug, and which instrument-holder is arranged to constrain the instrument to move along an axis passing through the point of intersection of the other axis.

The guideway fixed to the hollow plug may be arcuate and said other guideway may comprise a part which engages and slides along the first arcuate guideway and is itself formed with a second arcuate portion and wherein the instrument holder is provided with a part which engages and slides around the second arcuate guideway and is also formed with a rectilinear guide for said instrument.

Graduation scales may be provided along the length of the first and second said arcuate guideways and the guided parts are provided with marks respectively co-operating with the scales.

Means may be provided for clamping the guided parts in the desired position along their scales.

Preferably the aforesaid three axes intersect one another within the hollow plug.

In one form of the invention the first guideway is duplicated so as to provide similar and parallel arcuate guideways and the first guided part bridges the gap between those parallel guideways and has parts slidably engaging their width.

The duplicated guide may be fixed to the hollow plug by a plate member having a pair of upstanding flanges in which said parallel arcuate guideways are respectively formed and which plate member is detachably secured to the hollow plug.

The hollow plug may be threaded and tapered and may be provided with one or more pairs of holes for a tommy bar.

There may be provided a reference gauge aranged to fit into a fixed location in the hollow plug and which is formed with two marks spaced apart at a predetermined distance along the axis of the guideway, which marks are of such a character as to show in an X-ray photograph.

There may be also provided a depth gauge adapted to pass through the rectilinear guide which gauge is provided with a stop for limiting its movement through the guide and is of such a length as to be incapable of reaching the part of the brain to be operated upon and which gauge has a mark thereon which can be seen in an X-ray photograph for the purpose described.

Two alternative embodiments of the invention are now described by way of example as applied in a surgical instrument for use in operations on the brain,

[*Price* 4*s.* 6*d.*]

and the description makes reference to the drawings accompanying the Provisional Specification in which:—

Figure 1 is a part-sectional front elevational of one embodiment;

Figure 2 is a similar view to Figure 1 of a second embodiment which has a different type of guide tube and which does not have universally pivoted mounting;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is a plan view of the instrument shown in Figure 3;

Figure 5 shows a reference gauge for use in the instrument;

Figure 6 shows a depth gauge for use in the instrument.

Reference is also made to Figures 7 and 8 accompanying the Complete Specification which Figures are diagrammatic representations of X-ray photographs taken of the reference gauge in position on the skull.

Referring to the drawings the instrument comprises a super-structure made up of a frame 10 provided with upstanding end flanges 11 in which are cut parallel arcuate slots affording guideways 12. An arcuate guided member in the form of a bridge 13 spans the gap between the flanges 11 and has parts mounted in the guideways 12 and affords along its length a second arcuate guideway 8 in which slides a carrier or guide 19 for an operating or other instrument, the arrangement being such that the arcuate slots and the arcuate guideway 8 are struck respectively about two axes which intersect one another at right angles at a focal point 15

The part circular bridge 13 is provided with lugs 14 at its extremities which lugs overlie the flanges 11. Between the lugs 14 at each end of the bridge, a bight is cut away so that a scale marked in degrees on the part circular upper surface of the flanges 11 can be seen, and a mark to co-operate with the scale is provided in the bight at each end of the bridge and on the lengthwise line of symmetry of the bridge piece.

The bridge 13 is substantially of inverted channel section its web portion being bent in an arc of a circle which is centred at the focal point 15. The bridge piece can be clamped in any desired position relative to the guideways 12 by knurled wheels 16 which are engaged on studs 17 screwed into the ends of the bridge piece 13. The wheels 16 are provided with frusto-conical end portions 18 which engage in correspondingly chamfered outer edge portions 12*a* of the slots 12.

The bridge piece 13 is formed with a central slot along its length extending through the web portion of the channel section and together with the flanges of the channel section forming the second guideway 8 and mounted in the slot is a guided member constituting a carrier 19 for the operating or other instrument. The carrier comprises a T-shaped saddle piece 20, as viewed in side elevation, the cross piece of the T extending lengthwise of the guideway 8 and being provided with lugs 21 which contact the top surface of the bridge piece, and a zero mark 20*a* is provided on one side face of the saddle piece to co-operate with a scale marked in degrees on the top surface of the bridge piece. Part 20*b* of the leg of the T-piece 20 lies in the guideway 8 and is provided with flats on its sides preventing rotation of the T-piece in the guideway, and the lower end 20*c* of the T-piece extends below the lower edge of the guideway, is of reduced diameter and is screw threaded to receive a clamping nut 22 provided with a knurled head which nut engages the edges of the flanges of the channel. The saddle piece 20 is provided with a central drilling along its length and in the arrangement shown in Fig. 1 a continuation of the drilling is provided by a tubular locating element 24 which is held in abutment with the end 20*c* by a collar 23 threaded on the lower end 20*c* and having an internal flange engaging a peripheral flange on the upper end of the tube 24 and pressing it against the end of the part 20*c*. The lower end of the locating element is held in a universally pivoted mounting 25 which permits universal pivoting of the tube 24 about the point 15. The point 15 lies on the point of intersection of the axes about which the arcuate slots 12 and guideway 8 are struck.

In the arrangement shown in Figures 2 to 4 a guide tube 47 replaces the tube 24 and is inserted through the saddle piece 20 and the extension 20*c* of the saddle piece 20 and is provided with a flange 48 at its upper end which abuts against the saddle piece. A number of such guide tubes 24 or 47 may be provided having appropriate internal diameters for implements to be passed through them such as the depth gauge and cannula hereinafter referred to.

The scales marked on the flanges 11 and on the bridge piece 13 enable the angular position of an instrument carried by the guide tube to be defined in two planes at right angles to one another and the position of the tip of the instrument to be defined uniquely by the readings of the two scales.

The frame 10 affords in the base portion between the two flanges 11 a central boss 26 in which is detachably secured means for locating the instrument as a whole relative to the skull of the patient. The locating means comprises an annular member 27 comprising a tapered plug portion 27*a* the outer surface of which has cut into it a screw thread which is interrupted by grooves extending at right angles to the thread in

the manner of a screw cutting tap. The threaded plug is integral with a flange portion 27*b* which is of greater diameter than the plug and which is secured to the boss 26 as set out below. The flange is provided with a peripheral groove 28 the upper surface 28*a* of which is chamfered and is engaged by the conical ends of a pair of set screws 29 engaged in threaded holes in the boss 26, so that by screwing the set screws inwards the flange 27*b* is urged firmly into engagement with a shoulder 30 formed in the boss 26. Four radial holes 31 are drilled in the bottom of the groove 28 to provide two alternative positions for a tommy-bar. The internal surface of the threaded plug 27*a* is conical, and the internal surfaces of the flange 27*b* and the boss 26 are chamfered at 32 and 33 so as to provide a clearance for the guide tube 24 when the member 19 and the bridge piece 13 are at their respective limits of travel.

Figure 5 shows a neutral reference gauge 34 comprising a frusto-conical portion 35 and a reference rod portion 36. The portion 35 is provided with an identical taper to that of the internal surface of the plug 27*a* and the point 37 on the gauge 34 is at the same level as the focal point 15 when the gauge is positioned in the threaded plug 27*a*. The rod portion 36 of the gauge 34 is provided with two reference holes 38, 39 which are disposed at a distance apart equal to the distance of the hole 38 from the point 37 which is located at the focal point 15.

Figure 6 shows a depth gauge comprising a cannula 40 which is insertable through the carrier 19 and guide tube 24 or 47 and is of known length according to the position of the target so that it can not quite reach the target and has a head 45 which is arrested by the saddle piece 20 of the carrier. A small hole 46 is drilled through the cannula at 2 cms from its tip 43.

In use a burr hole of suitable size (16—18 mm burr) is made at an appropriate site in the skull, (say on the coronal suture 5 cms from the midline). Ventricular detail is visualised by lumbar encephalography or by direct tap of the frontal horn through the burr hole. When sufficient detail has been obtained the threaded plug 27*a* is screwed into the burr hole until the thread is securely anchored in the skull, if necessary with the assistance of the aforesaid tommy bar which is introduced into one of the holes 31. This however, is seldom necessary. While the threaded plug 27*a* is being screwed into position it is advisable to keep the flange portion 27*b* tangential to the curvature of the head. The reference gauge (Figure 5) is then inserted into the threaded plug, the mating of the coned surfaces making this joint stable while the patient is positioned for X-rays.

The patient is placed supine, with the sagittal plane of the head as close to the vertical as can be achieved by the eye. Lateral and antero-posterior films (X-ray) are taken, using the longest tube-film distance that can be obtained conveniently. These film,s are developed and dried. Diagrammatic reproduction of such films are shown in Figures 7 and 8. Taking each X-ray film individually the target point 49 is plotted from the usual landmarks. The reference rod 36 shows on the films and its direction is continued down as a fine pencil or scratch line 41 into the skull space. The two holes 39 and 38 drilled into the rod are visible on the films, and the distance between these is measured with calipers. An equal distance from the lower hole 38, downwards along the line of the reference rod will determine the aforesaid focal point 15. If a short tube-film distance has been used a correction will have to be made for magnification error. By drawing a line 42 from the target point 49 to the point 15 an angle of correction 50 can be measured between this line and the line of the reference rod 36. A similar angular measurement 51 is made from the X-ray film in the other plane.

When the angles have been determined the reference gauge 34 is removed from the member 27 and the super-structure is set up on an adjacent table. By moving the carrier 19 to an appropriate position one of the angles, say the angle 50, is set on the bridge piece 13 taking care that the angle is made in the correct direction i.e. either towards or away from the midline of the head. The bridge piece 13 itself is then moved along the guideways 12 to a setting corresponding to the angle of correction 51 obtained from the other X-ray film, with the same precautions as to direction. The superstructure is now ready, and is placed in contact with the threaded plug 27*a* rotating on the flange portion 27*b* until each is in what is judged to be the correct plane appropriate to the directions from which the X-ray photographs were taken. The thumb screws 16 are then tightened. Thus one of the arcs, say the bridging arc, should be set parallel to the sagittal plane of the head, the other being parallel to the coronal plane.

In order to check the correctness of the setting and to determine the length of the cannula to be used in the operation the depth gauge 40 (Figure 6) with its guide tube 24 or 47 is fitted into the carrier 19 and passed on into the brain; it will be in the direction of the target point 49 but will fall somewhat short of that point, usually by 2—3 cms. Further X-ray photographs in the two planes are required at this stage, both as a check on the direction and to show the position of the hole 46 which is drilled 2 cms from the end of the gauge. Good quality X-rays are necessary and it is advisable to rotate the

depth gauge before each film is exposed, until the hole 46 is so aligned that it will most clearly show. When these films are developed the accuracy of the siting of the carrier can be checked. If no further corrections are necessary the distance from the end of the depth gauge to the target point is measured from the films. The reduction factor, to discount magnification error, is obtained by measuring from the films the distance between the hole 46 and the end of the gauge, a distance which is known in fact to be exactly 2 cms. By this means there can be calculated how much longer than the depth gauge a cannula would have to be to just reach the target point.

The depth gauge and its guide tube 24 or 47 is removed from the carrier and a cannula, or electrode with its guide tube are inserted so that the former may be passed the required distance into the brain. Then the lesion is made by whatever method is favoured.

WHAT I CLAIM IS:—

1. An instrument for use in brain surgery comprising a hollow plug for assemblage in a hole formed in the skull of the patient which plug forms the sole support for the instrument on the patient's head, a guideway fixed to the plug and arranged to constrain a part of another guideway to swing about a first axis tranverse to the axis of the hollow plug which other guideway constrains an instrument-holder to swing about an axis at right angles to and intersecting the first axis and the axis of the hollow plug, and which instrument-holder is arranged to constrain the instrument to move along an axis passing through the point of intersection of the other axes.

2. An instrument according to Claim 1 wherein the guideway fixed to said hollow plug is arcuate and said other guideway comprises a part which engages and slides along the first arcuate guideway and is itself formed with a second arcuate portion and wherein the instrument holder is provided with a part which engages and slides around the second arcuate guideway and is also formed with a rectilinear guide for said instrument.

3. A surgical instrument according to Claim 2 wherein graduated scales are provided along the length of the first and second said arcuate guideways and the guided parts are provided with marks respectively cooperating with the scales.

4. A surgical instrument according to Claim 3 wherein means are provided for clamping the guided parts in the desired position along their scales.

5. A surgical instrument according to any of the preceding claims wherein said three axes intersect one another within the hollow plug.

6. A surgical instrument according to any of Claims 2 to 5 wherein the first guideway is duplicated so as to provide similar and parallel arcuate guideways and the first guided part bridges the gap between these parallel guideways and has parts slidably engaging their width.

7. A surgical instrument according to Claim 6 wherein the duplicated guide is fixed to the hollow plug by a plate member having a pair of upstanding flanges in which said parallel arcuate guideways are respectively formed and which plate member is detachably secured to the hollow plug.

8. A surgical instrument according to Claim 7 wherein the hollow plug is threaded and tapered and is provided with one or more pairs of holes for a tommy bar.

9. A surgical instrument according to any of Claims 2 to 8 wherein there is provided a reference gauge arranged to fit into a fixed location in the hollow plug and which is formed with two marks spaced apart at a predetermined distance along the axis of the hollow plug, which marks are of such a character as to show in an X-ray photograph.

10. A surgical instrument according to any of Claims 2 to 7 wherein there is provided a depth gauge adapted to pass through the rectilinear guide which gauge is provided with a stop for limiting its movement through the guide and is of such a length as to be incapable of reaching the part of the brain to be operated upon and which gauge has a mark thereon which can be seen in an X-ray photograph for the purpose described.

11. A method of using a surgical instrument according to Claim 10 substantially as described.

12. A surgical instrument substantially as described with reference to and as illustrated in Figures 1, 5 and 6 of the drawings accompanying the Provisional Specification.

13. A surgical instrument substantially as described with reference to and as illustrated in Figures 2 to 6 of the drawings accompanying the Provisional Specification.

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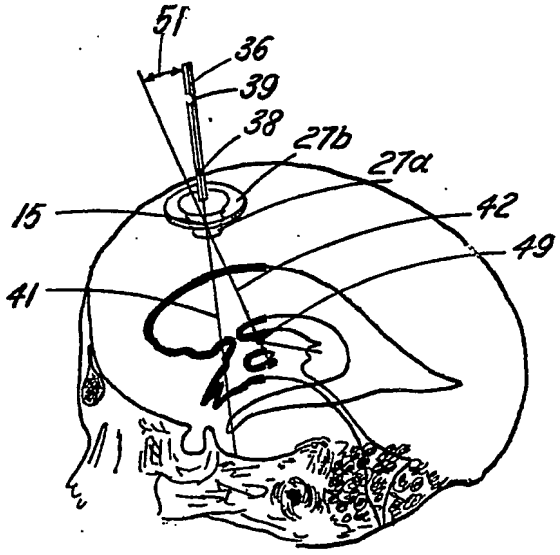
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.8.



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PROVISIONAL & COMPLETE SPECIFICATION

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Fig.4.

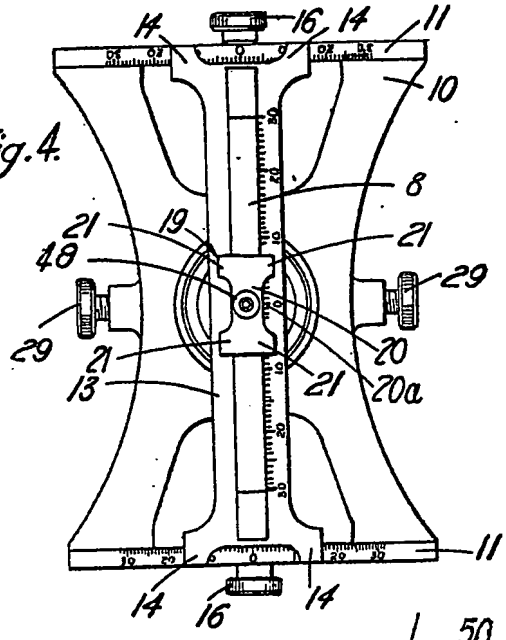

Fig.7.

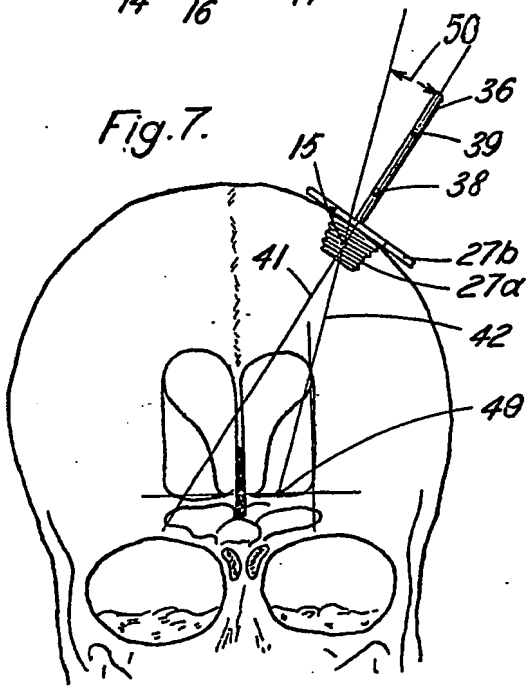

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Fig.1.

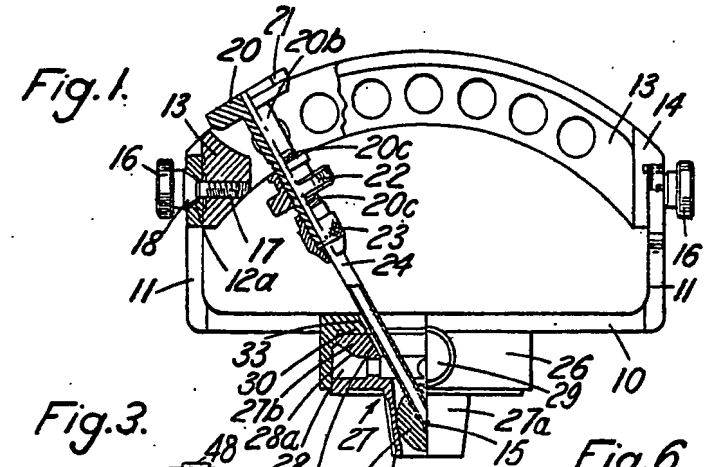

Fig.3.

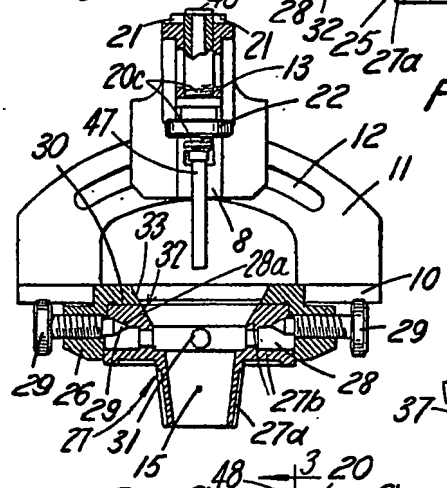

Fig.6.

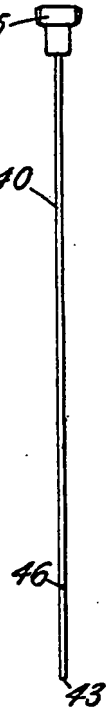

Fig.5.

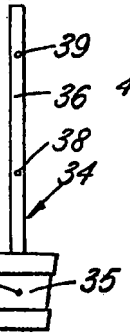

Fig.2.